

# **SPEECH+**<sup>TM</sup>

## **Owner's Manual**



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S17403B  
Printed in U.S.A.



PHOTO IS  $\frac{3}{4}$  SCALE

Attachment point for optional  
theft-inhibiting cable

LED display for 8 digits,  
decimal, and sign

Impact-resistant plastic case

On-off/Volume Control

Insert Battery  
Charger here

Memory Key

Square Root Key

Percent Key

Clear Key

Insert Earphone  
jack here

Equals Key

Speak Key

Speech Suppressor  
Switch

Swap Key

Change Sign Key

The 4 basic function keys

Number-entry Keys in push-button phone format

Decimal Point Key



## FEATURES OF THE SPEECH PLUS™ CALCULATOR

**Algebraic Logic** — number and function keys are pressed in the same sequence as the equation is expressed.

**Automatic constant** — simplifies repeated calculations which share the same number.

**Floating decimal point** — calculator automatically positions decimal point; to simplify monetary calculations, a minimum of two digits are announced following the decimal point.

**8 digit visual display** with space for negative number, overflow, and low battery indicators.

**Four basic functions, square root, and percent** — Percent Key has constant to simplify repeated calculations.

**Change Sign Key** — reverses the sign of the display number.

**Independent memory** — display number can be added to or subtracted from memory number; memory recall does not disturb memory; Swap Key exchanges display with memory without disturbing operations in process.

**Special keyboard** — layout adapted for accuracy and compatibility with push-button telephone; keyboard graphics designed for high legibility.

**Speech** — produced by solid state components and one moving part, the speaker.

**24 word vocabulary** — provides complete spoken verification of calculation; includes warnings for overflow and low battery conditions.

**Public or private listening** via internal speaker or earphone; calculator also has Speech Suppressor Switch for silent entry.

**Volume control** — control can be pre-set; volume loud enough for use in a small classroom.

**Rapid number entry** — speech verification does not limit speed of entry, words are abbreviated instead.

**Internal battery supply** — no batteries to replace; over three hours continuous speaking use without recharging; battery extender circuit reduces discharge during silent periods.

**Portable** — approximately one pound; simulated leather case has earphone pocket and wrist strap.

**Instructions** — In print, braille, or on cassette.

**Metal attachment point** — for optional theft-inhibiting cable.


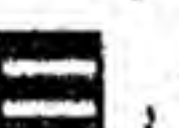


The SPEECH PLUS™ calculator may be used for everyday problems or advanced calculations. Its spoken verification for all keys insures accuracy and reduces calculation time. Its portability and long battery life provide versatility. Once you are familiar with operating the SPEECH PLUS calculator, you will find an increasing number of uses for it.

## LAYOUT

**The On-off/Volume control** is located at the right top corner of the calculator. To turn the machine on, pull the knob out. The calculator will announce "clear" and be prepared to receive entries. To increase the volume, turn the knob clockwise. The raised line running the length of the knob shows the volume level and can be used to pre-set the volume.

**The earphone jack** is on the right end of the calculator.

**The battery charger jack** is on the left end of the calculator.

**The Keyboard:** The two columns of keys on the left side of the keyboard contain the function, Clear and Memory keys. The center three columns of the keyboard contain the numbers arranged like the keyboard of a push-button telephone. The bottom row of this section includes the decimal point, zero, and the Change Sign Key . The single column on the right contains the Equals Key , the Speak Key , the Speech Suppressor Switch which determines whether entries will be silent or spoken, and the Swap Key  which exchanges the display number with the memory number.



## OPERATION

Sample problems should help you understand how to use the SPEECH PLUS calculator. Explanations of important keys and concepts precede the calculations. As you work the problems, remember that you can press the Speak Key at any time to check a number on display. The Speak Key provides for display readout but will not influence calculations.

**Digit Keys 0-9** enter numbers for calculations; numbers of more than one digit are entered in normal order from left to right, from most to least significant digit; calculator says "oh" for zero. If more than 8 digits are entered for a number, all digits are announced, but only the first 8 are retained for subsequent calculations.

**Decimal Key** enters decimal; press in normal sequence; vocabulary: "point."

**Arithmetic functions keys**  $+$ ,  $-$ ,  $\times$ , and  $\div$  first complete any pending operation and then prepare the calculator to process the next entry. These keys are entered in order of calculation expression; vocabulary: "plus," "minus," "times," "over." If you accidentally press the wrong one of these function keys, you can correct the mistake by immediately pressing the correct key.

**Equals Key** is most often used to complete an operation and display the results. But when pressed after the Memory Key

("em") in the dual keystrokes  $\text{M} =$ , it helps recall memory.

(See pages 12 and 13.) The Equals Key is also used in conjunction with the automatic constant feature for raising numbers to powers, tally counting, and the like. (See page 10 for examples.)

The Equals Key does not announce the number of the display.

**Speak Key** announces what is on the display in sequence from left to right; a negative display is preceded by "minus;" the Speak Key may be pressed at any time for display readout without initiating further calculations. The Speak Key must be pressed to hear the result at the end of the calculation.

**Note:** The **Speech Suppressor Switch** may be used to turn the speech off during calculation entry. If the switch is toward the Speak Key the calculator will speak during entry.

**Clear Key** is used to clear the latest entry or to clear the display and accumulated entries. If a mistake is made entering a number, pressing  $\text{C}$  once will clear that mistake from the display but leave previous entries intact. Pressing  $\text{C}$  twice will clear the display and all accumulated entries, but not memory. (See Memory and Overflow sections on pages 12-14 for further use of the Clear Key.)

It is not necessary to press  $\text{C}$  before starting a new calculation

when the last calculation was completed with an Equals Key.

If the new calculation begins with a number key, the preceding display number is automatically cleared. If it begins with a function key, the display number will be used as the first factor in the new calculation.

If you mistakenly pressed one of the four basic function keys ( $+$ ,  $-$ ,  $\times$ ,  $\div$ ) and meant to press a different one of those four keys, you don't need the Clear Key for correction. Simply press the correct function key.

## EXAMPLES

### Addition and subtraction

1.  $1.23 + 45.0 - 6.789 = 39.441$

$1.23 \text{ } + \text{ } 45 \text{ } - \text{ } 6.789 \text{ } = \text{ } 39.441$

### Multiplication

2.  $1.23 \times 0.456 \times 7 = 3.92616$

$1.23 \text{ } \times \text{ } .456 \text{ } \times \text{ } 7 \text{ } = \text{ } 3.92616$

### Division

3.  $\frac{123.0}{4} = 30.75$

$123 \text{ } \div \text{ } 4 \text{ } = \text{ } 30.75$

### Mixed calculation

4.  $\frac{(1.2 \times 3.45) + 67.8}{9.1} = 7.9054945$

$1.2 \text{ } \times \text{ } 3.45 \text{ } + \text{ } 67.8 \text{ } \div \text{ } 9.1 \text{ } = \text{ } 7.9054945$

### Correcting entry mistakes

#### 5. Number entry mistake\*

$1.23 + 4.56 = 5.79$

$1.23 \text{ } + \text{ } 4.53 \text{ } \text{C} \text{ } 4.56 \text{ } = \text{ } 5.79$

**Note:** Pressing  $\text{C}$  twice would have cleared everything but memory and required reentry of the entire equation.

#### 6. Entry mistake involving two of the four basic function keys\*

$1.23 + 4.56 = 5.79$

$1.23 \text{ } - \text{ } * \text{ } + \text{ } 4.56 \text{ } = \text{ } 5.79$



**The Floating Decimal.** The calculator generally displays at least two digits to the right of the decimal point in an answer, even when the result is a whole number. For example, the answer "8" is displayed "8.00." This standard placement is designed to simplify monetary calculations. The calculator also has an automatic floating decimal. Notice that the decimal is positioned correctly in the results in previous examples.

**The Change Sign Key** changes the sign of an already-displayed number. This key must be used to enter a negative number. The Change Sign Key cannot be pressed until at least part of the number is entered (and, therefore, on display). Vocabulary: "times minus."

**The Square Root Key** generates the square root of the display number and displays the result. Vocabulary: "root." Note: Pending operations must be completed by pressing the Equals Key prior to pressing the Square Root Key. It is not necessary to press the Equals Key following the Square Root Key. (See problem 9.)

**Automatic Constant operation.** In addition, subtraction, multiplication, and division, the last function and numeric entry before the Equals Key are retained for repeated use. The Automatic Constant feature is extremely useful to raise numbers to powers, to obtain reciprocals, and to calculate compound interest. (Examples of these uses are shown on page 10 following more-basic examples.)

## EXAMPLES

### Using the Change Sign Key

7.  $2 \times (-34) = -68$

$2 \times 34 \times \text{Change Sign} = -68.00$

or  $2 \times 3 \times 4 \times \text{Change Sign} = -68.00$

Note:  $2 \times \text{Change Sign} \times 34 =$  gives an incorrect

68.00 because none of the number 34 was on display when

$\times$  was pressed. Also,  $2 \times \text{Change Sign} \times 34 =$  gives an

incorrect -32.00 because the  $\text{Change Sign}$  overrides the  $\times$ .

### Using the Square Root Key

8.  $\sqrt{81} = 9$

$81 \sqrt{\phantom{x}} = 9.00$

9.  $\sqrt{40 + 41} = 9$

$40 + 41 = \sqrt{\phantom{x}} = 9.00$

### Automatic Constant used with 4 functions

10.  $1 + 5 = 6, 2 + 5 = 7$

$1 + 5 = 6.00, 2 = 7.00$

11.  $9 - 5 = 4, 8 - 5 = 3$

$9 - 5 = 4.00, 8 = 3.00$

12.  $2 + 3 + 3 - 4 - 4 = 0$

$2 + 3 = 5, 5 + 3 = 8, 8 - 4 = 4, 4 - 4 = 0.00$

13.  $3 \times 4 = 12, 4 \times 4 = 16$

$3 \times 4 = 12.00, 4 = 16.00$

14.  $12 \div 3 = 4, 45 \div 3 = 15$

$12 \div 3 = 4.00, 45 = 15.00$



**The Equals Key for powers, squaring, and reciprocals.**

Notice what happens when the Equals Key follows immediately after one of the four basic function keys, with no number in between. The calculator uses the number on display a second time, as the automatic constant.

**EXAMPLES****Raising to powers**

15.  $(2)^3 = 8$

$2 \text{ [X]} [=] [=] [=] 8.00$

**Squaring**

16.  $(3^2)^2 = 81$

$3 \text{ [X]} [=] \text{ [X]} [=] [=] 81.00$

**Finding reciprocals.** Whenever you press the 3-key combination  $\div [=] [=]$ , the calculator will complete pending operations (if there are any) and then provide the reciprocal of the result.

With no pending operation—

17. Assume the answer 6.00 of a previous calculation ( $2 \times 3 = 6$ ) is on display. (Press  $\text{[C]}$ ,  $2 \text{ [X]} 3 [=] [=] 6.00$ .) For the reciprocal of that displayed result, press  $\div [=] [=] [=] 0.1666666$

With an operation pending—

18. Create an example of an incomplete calculation by pressing  $\text{[C]}$  and  $2 \text{ [X]} 3$ . For the reciprocal of the result of the statement  $2 \times 3$ , press  $\div [=] [=] [=] 0.1666666$

Note that keystrokes  $\div [=] [=]$  gave the reciprocal of the result of the pending operation, not the reciprocal of "3" which was on display.

**The Percent Key**, like the Square Root Key, completes the percentage calculation and immediately displays the answer without the Equals Key. The Percent Key may also be used with other function keys (and in some cases the Equals Key) to perform add-on, discount, mark-up, and yield calculations.

**EXAMPLES****Simple percent** (doesn't require Equals Key)

19.  $5\% \text{ of } 120 = 6$

$120 \text{ [X]} 5 \text{ [%]} [=] 6.00$

**Add-on** (requires the Equals Key)

20.  $150 + 5.5\% \text{ of } 150 = 158.25$

$150 \text{ [+]} 5.5 \text{ [%]} [=] [=] 158.25$

Note: The intermediate result 8.25 (5.5% of 150) is displayed after the Percent Key is pressed and until the Equals Key completes the calculation.

**Discount and Chain Discount** (requires the Equals Key)

21.  $150 - 5.5\% \text{ of } 150 = 141.75$

$150 \text{ [-]} 5.5 \text{ [%]} [=] [=] 141.75$

22.  $150 - 10\% - 15\% = 114.75$

$150 \text{ [-]} 10 \text{ [%]} \text{ [-]} 15 \text{ [%]} [=] [=] 114.75$

**Mark-up**

23. What is the price if the cost is \$30 and the mark-up must be 40% (of the price)? If the cost is \$33?

$30 \text{ [÷]} 60 \text{ [%]} [=] 50.00$

\*(60 = 100 minus mark-up)

$33 \text{ [%]} [=] 55.00$

Note: The 100-minus-mark-up computation may be done first and stored in memory. (Be sure memory is clear.)

$100 \text{ [-]} 40 \text{ [=] [M+]} , 30 \text{ [÷] [M] [%]} [=] 50.00$

See Memory Key section for memory operations.

**Yield**

24. What is the yield if you get 14 good units out of 20?

(Answer: 70%.) If you get 18 good units? (Answer: 90%.)

$14 \text{ [÷]} 20 \text{ [%]} [=] 70.00, 18 \text{ [%]} [=] 90.00$



**The Memory Key** is used with five other keys in two-key sequences.

$\boxed{M} \boxed{+}$  adds the display number to memory.  $\boxed{M} \boxed{-}$  subtracts the display from memory.  $\boxed{M} \boxed{C}$  clears the memory.  $\boxed{M} \boxed{=}$  recalls the memory for display and use without affecting the contents of memory.  $\boxed{M} \boxed{S}$  (or  $\boxed{S}$  by itself) puts memory on display by swapping memory with display. Although  $\boxed{M} \boxed{=}$  and  $\boxed{S}$  (or  $\boxed{M} \boxed{S}$ ) remove a number from display in order to display memory, they do not disturb operations that may be set up, such as those involving automatic constant.

**Clearing Memory.** Do not mistakenly assume memory is clear. It is clear when the calculator is first turned on. After that, to clear memory you must either press  $\boxed{M} \boxed{C}$  or put "0" on display—usually with the Clear Key—and then press  $\boxed{S}$  (or  $\boxed{M} \boxed{S}$ ). (If a number entry follows  $\boxed{S}$ , the number that was on display will be eliminated.)  $\boxed{M} \boxed{C}$  can be pressed at any time except during the middle of a number entry.

**The Swap Key** exchanges display and memory and can be used repeatedly. It substitutes for  $\boxed{M} \boxed{=}$  when the contents of memory are to be used only once in a calculation. (i.e. Don't use the Swap Key to enter a memory number into a calculation if you'll need that number again.) The key also provides the easiest way to enter a display number into memory by itself without regard for previous memory contents. (In many cases,  $\boxed{S}$  replaces keystrokes  $\boxed{M} \boxed{C}$  and  $\boxed{M} \boxed{+}$ .) Finally, the Swap Key is used to check memory. Unlike  $\boxed{M} \boxed{=}$ ,  $\boxed{S}$  allows you to re-display the number that was on display before memory was checked.

## EXAMPLES

### Adding to and recalling memory

(First clear memory with  $\boxed{M} \boxed{C}$ .)

25.  $(2 \times 3) + (4 \times 5) = 26$

$2 \boxed{\times} 3 \boxed{= M} \boxed{+}, 4 \boxed{\times} 5 \boxed{= M} \boxed{+ M} \boxed{=}$  26.00

(15 keystrokes)

or  $2 \boxed{\times} 3 \boxed{= M} \boxed{+}, 4 \boxed{\times} 5 \boxed{+ M} \boxed{=}$  26.00

(14 keystrokes)

Note: The dual keystroke  $\boxed{M} \boxed{=}$  recalls the number in memory. The next Equals Key completes the operation.

### Using the Swap Key

As a substitute for  $\boxed{M} \boxed{=}$  —

26.  $(2 \times 3) + (4 \times 5) = 26.00$

$2 \boxed{\times} 3 \boxed{= M} \boxed{+}, 4 \boxed{\times} 5 \boxed{+ S} \boxed{=}$  26.00

(13 keystrokes)

To enter display number by itself into an occupied memory—

27. With the number 1000 already in memory, calculate

$(2 \times 3) + (4 \times 5) = 26$  without using  $\boxed{M} \boxed{C}$

To establish the conditions, press  $\boxed{C} \boxed{M} \boxed{C}$

1000  $\boxed{M} \boxed{+}$ . Then, do the sample problem:

$2 \boxed{\times} 3 \boxed{= S}, 4 \boxed{\times} 5 \boxed{+ M} \boxed{=}$  26.00

(13 keystrokes)

Notice the answer is 26, not 1026 or 50,026.

As both a substitute for  $\boxed{M} \boxed{=}$  and to enter a solitary number into an occupied memory—

28. With the number 1000 already in memory, calculate

$(2 \times 3) + (4 \times 5) = 26$  without  $\boxed{M} \boxed{=}$  or  $\boxed{M} \boxed{C}$ .

To establish the conditions, press  $\boxed{C} \boxed{M} \boxed{C}$

1000  $\boxed{M} \boxed{+}$ . Then, do the same problem:

$2 \boxed{\times} 3 \boxed{= S}, 4 \boxed{\times} 5 \boxed{+ S} \boxed{=}$  26.00 (12 keystrokes)



### Overflow, underflow, and error conditions.

Overflow occurs if an answer exceeds  $\pm 99999999$ . The SPEECH PLUS calculator then lights the overflow indicator on the visual display and shifts the decimal point so that the correct answer can be obtained by mentally multiplying the display by  $10^6$ . When the Speak Key is pressed, "overflow" is announced before the display readout. The keyboard is inhibited and "overflow" is announced after any subsequent keystrokes.

If overflow occurs in the midst of a calculation, pressing  $\text{C}$  once divides the display by  $10^6$ , thereby eliminating overflow and allowing completion of the calculation. (The display result, then, must be mentally multiplied by  $10^6$  for the correct answer.)

Underflow occurs if a number has more than the 8 significant digits shown on the display but is not large enough to overflow. Example: 12345.67891 has 10 significant digits and is less than 99999999. The display would indicate 12345.678.

An error condition occurs if an entry is mathematically illogical, such as the square root of a negative number or the  $\text{M}$  followed by a number key. The calculator will use "overflow" to indicate this.

### EXAMPLES

#### Overflow

29.  $12340 \times 10,000 = 123,400,000 (1.234 \times 10^6)$

$12340 \times 10000 = 1$  "overflow" 1.234

30.  $12345 \times 10,000 \times 3 = 370,350,000 (3.7035 \times 10^6)$

$12345 \times 10000 \times 3$  "overflow"  $\text{C}$  3 = 3.7035

Note that "3" wasn't announced the first time. Because "overflow" was announced "3" had to be re-entered.

#### Underflow

31.  $12345.67891 \times 1 = 12345.67891$

$12345.67891 \times 1 = 1$  12345.678

Note that the least significant digits were cut off.

#### Error Condition

32.  $\sqrt{-44}$

$44 \sqrt{\phantom{x}} = 1$  "overflow 44."  $\text{C}$  1 -44.

### BATTERY AND CHARGER

The SPEECH PLUS calculator has an internal, rechargeable nickel-cadmium battery to allow completely portable operation. Operating time depends on usage patterns, but it is typically more than 3 hours of continuous "talking" use. Battery life depends upon operating temperature, how frequently and deeply the battery is discharged, and other factors, but it is approximately 1000 recharging cycles.

With the power switch off, the recharging time is 4-8 hours. However, the calculator will operate and charge at the same time. The battery cannot be overcharged. It will not be damaged if the charger is plugged in indefinitely.

**When the battery is low**, entries are not announced and "low" is announced before each result. Whenever possible, plug in the charger at the first sign of low batteries, even though there is enough charge for a few more minutes of portable use. This will help prevent excessive battery discharges which, if routine, can permanently damage batteries. (If a battery is severely discharged, recharge it overnight.)

Battery operating time may be stretched by turning the machine off between calculations and by silencing entry keystrokes with the Speech Suppressor Switch. (Switch it away from the Speak Key to turn speech off during entry.)

If it seems that the operating time between recharges has decreased, there may be internal changes in the battery which can be corrected. Try discharging the batteries completely by leaving the calculator on overnight. Then recharge the calculator for about 6 hours. This severe discharge—if not routine—should not endanger the long term life of the battery.

**CAUTION:** USE OF THE WRONG CHARGER OR BATTERY CAN RESULT IN EXPLOSION OF THE BATTERY FROM EXCESSIVE HEAT. ONLY A TSI-SPECIFIED SPEECH PLUS CHARGER SHOULD BE USED. THE WARRANTY ON THE SPEECH PLUS CALCULATOR WILL BE VOID IF BATTERIES ARE REPLACED BY OTHER THAN A TSI-AUTHORIZED SERVICE REPRESENTATIVE.

A calculator shipped to TSI for service must be accompanied by its charger.



### USER HINTS

Many people operate the SPEECH PLUS calculator with two hands, with the calculator rotated slightly counter-clockwise, the left hand controlling the two function columns and the right hand operating the rest. The 5-key is a "home key" and has a raised dot.

Like a typist, you can't enter two keys at once. Press the keys decisively, then lift up. If you continue pressing on one key, you can't enter another.

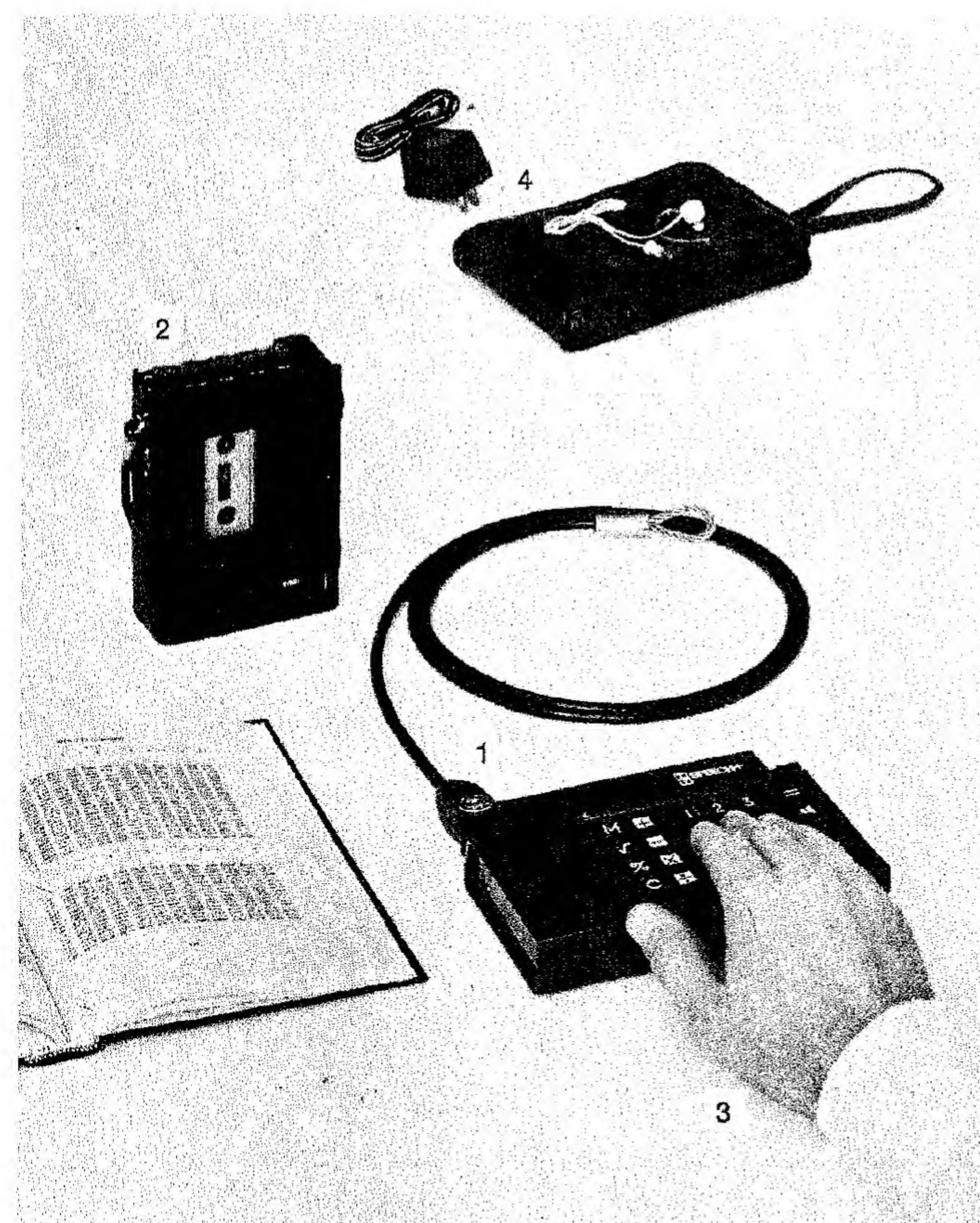
At times, you may find it useful to tape record your work. Use a microphone rather than a direct jack so you can explain your calculations as you proceed.

#### If your SPEECH PLUS calculator isn't working:

1. Check that the power switch is on (pulled out) and the volume is turned up (clockwise).
2. See whether the Speech Suppression Switch is toward the Speak Key (for spoken entries).
3. Charge the calculator for a few minutes with power off, then try using it with the charger plugged in.
4. If it still doesn't work, recharge it overnight with the calculator turned off.
5. If it still doesn't work, return it safely packaged with the charger to your factory-authorized service representative listed below. Don't attempt battery replacement yourself. Unauthorized service may void your warranty.

Service Department  
Telesensory Systems, Inc.  
1889 Page Mill Road  
Palo Alto, CA 94304  
415/493-2626

(If your area is being served by additional Service Centers at the time you buy your calculator, those will be listed on a separate card included in the shipping carton.)



1. Optional theft-inhibiting cable is locked to calculator.
2. Cassette provides lasting record of SPEECH PLUS calculations and user-voiced descriptions of purposes and processes.
3. One hand position shows middle finger on the "5" home key and the thumb poised near the Clear Key. Little finger strikes Equals and Speak Keys.
4. Earphone, charger, and vinyl carrying case with wrist strap.



## ADVANCED ELECTRONICS AND CUSTOM DESIGN

### Reasons and Objectives

The SPEECH PLUS™ calculator is the first calculator capable of announcing all entry keystrokes and answers. Yet it is portable and reasonably priced.

This calculator is not an assembly of standard calculator circuits and hardware. Instead, almost every part of the SPEECH PLUS calculator has been custom-designed with specific objectives.

TSI has custom-programmed a microcomputer in the SPEECH PLUS calculator and is a pioneer in the use of this device. This microcomputer contains the calculating capability. It was used instead of more-conventional, commercially available parts so that we could dictate the way the calculator works and design the keyboard. As a result, the SPEECH PLUS calculator's straightforward operating logic allows increased accuracy and is appropriate for both math instruction and everyday use. The keyboard does not include unnecessary keys.

TSI custom-designed the SPEECH PLUS keyboard for accuracy during non-visual operation. It results from an extensive TSI human factors study which started with a study of 19 commercially available keyboards evaluated by over 50 test participants. Keys in the number entry section are arranged like those on a push-button telephone due to the overwhelming preference of blind users for this feature.

The speech circuit for the 24 word vocabulary involves patent-pending technology. The speaker is the only moving part and there are two large scale integrated circuits. One is a custom, special purpose microprocessor TSI developed to replace 50 separate integrated circuit packages. (This was designed expressly for the SPEECH PLUS calculator.) The other is a TSI-programmed Read Only Memory (ROM) which has a copyrighted output.

Other design decisions reflect TSI's attention to detail and user convenience.

### LIMITED WARRANTY

The SPEECH PLUS™ calculator is warranted against defects in materials and workmanship for one year from the date of delivery. During this warranty period, Telesensory Systems, Inc. (TSI) will repair or replace defective components at no charge if the calculator is returned prepaid with its charger.

TSI shall not be liable under this warranty if the calculator has been damaged, if the serial number has been altered, if the calculator has been serviced or modified, or if the batteries have been changed, by anyone other than a TSI-authorized service representative (or other service person meeting TSI requirements and approved in writing by TSI).

TSI DISCLAIMS ALL OTHER GUARANTIES AND WARRANTIES INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

TSI shall not be liable for incidental consequential damages; in no event shall TSI be liable except for repair, replacement or refunding the purchase price of a calculator.